

Federal Aviation Administration – [Regulations and Policies](#)
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area
Engine Harmonization Working Group

Task 7 – Fire Prevention

Task Assignment

DEPARTMENT OF TRANSPORTATION**Federal Aviation Administration****Aviation Rulemaking Advisory Committee (ARAC); Engine Harmonization Working Group**

AGENCY: Federal Aviation Administration (FAA), DOT.

ACTION: Notice of new task assignments for the Aviation Rulemaking Advisory Committee.

SUMMARY: Notice is given of new task assignments for the Engine Harmonization Working Group of the Aviation Rulemaking Advisory Committee (ARAC). This notice informs the public of the activities of the ARAC.

FOR FURTHER INFORMATION CONTACT: Mr. Michael Borfittz, Assistant Executive Director for Transport Airplane and Engine Issues, Aviation Rulemaking Advisory Committee, FAA Engine & Propeller Directorate, 12 New England Executive Park, Burlington, Massachusetts 01803; telephone (617) 238-7110, fax (617) 238-7199.

SUPPLEMENTARY INFORMATION: On January 22, 1991 (56 FR 2190), the Federal Aviation Administration (FAA) established the Aviation Rulemaking Advisory Committee (ARAC). The committee provides advice and recommendations to the FAA Administrator, through the Associate Administrator for Regulation and Certification, on the full range of the FAA's rulemaking activities with respect to aviation-related issues.

In order to develop such advice and recommendations, the ARAC may choose to establish working groups to which specific tasks are assigned. Such working groups are comprised of experts from those organizations having an interest in the assigned tasks. A working group member need not be a representative of a member of the full committee. One of the working groups established by the ARAC is the Engine Harmonization Working Group.

The FAA announced at the Joint Aviation Authorities (JAA)—Federal

Aviation Administration (FAA) Harmonization Conference in Toronto, Canada, (June 2-5, 1992), that it would consolidate within the ARAC structure an ongoing objective to "harmonize" the Joint Aviation Requirements (JAR) and the Federal Aviation Regulations (FAR).

Tasks

The Engine Harmonization Working Group new tasks are as follows:

Task 1, Fire Prevention—Review FAR and JAR requirements and create one set of common requirements (FAR 33.17; JAR-E-530).

Task 2, FAR 35—Conduct a comparison of FAR Part 35 and JAR-P requirements and advisory material and identify significant differences. This comparison should clarify and redefine existing requirements to include new standards to reflect recent advancements in design and construction of composite material propellers, propeller control systems (such as dual acting control systems) and electronic controls.

Reports

For each task listed, the Engine Harmonization Working Group should develop and present to the ARAC:

1. A recommended work plan for completion of the tasks, including the rationale supporting such a plan, for consideration at the meeting of the ARAC to consider transport airplane and engine issues held following publication of this notice;
2. A detailed conceptual presentation on the proposed recommendation(s), prior to proceeding with the work stated in item 3. below;
3. A draft Notice of Proposed Rulemaking, with supporting economic and other required analyses, and/or any other related guidance material or collateral documents the working group determines to be appropriate; or, if new or revised requirements or compliance methods are not recommended, a draft report stating the rationale for not making such recommendations; and
4. A status report at each meeting of the ARAC held to consider transport airplane and engine issues.

Participation in Working Group Task

An individual who has expertise in the subject matter and wishes to become a member of the working group should write to the person listed under the caption **FOR FURTHER INFORMATION CONTACT** expressing that desire, describing his or her interest in the task(s), and stating the expertise he or she would bring to the working group. The request will be reviewed with the assistant chair and working group chair,

and the individual will be advised whether or not the request can be accommodated.

The Secretary of Transportation has determined that the formation and use of the Aviation Rulemaking Advisory Committee are necessary in the public interest in connection with the performance of duties imposed on the FAA by law.

Meetings of the Aviation Rulemaking Advisory Committee will be open to the public, except as authorized by section 10(d) of the Federal Advisory Committee Act. Meetings of the working group will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on August 10, 1994.

Chris A. Christie,
Executive Director, Aviation Rulemaking Advisory Committee.
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Recommendation – Not Available

Acknowledgement Letter



U.S. Department
of Transportation
**Federal Aviation
Administration**

800 Independence Ave., S.W.
Washington, D.C. 20591

MAR 15 2001

Mr. Craig Bolt
Assistant Chair, Transport Airplane
and Engine Issues
400 Main Street
East Hartford, CT 06108

Dear Mr. Bolt:

We apologize for the delay in acknowledging receipt of three documents submitted in March and April 2000. You specifically requested formal legal and economic review of draft notices of proposed rulemakings and accompanying advisory circulars addressing:

- Uniform safety analysis for aircraft turbine engines;
- Rating standards for failure or shutdown of one engine in multi-engine rotorcraft during takeoff or landing, and
- Propellers.

Although operating procedures for the Aviation Rulemaking Advisory Committee (ARAC) specify that the FAA will conduct its review of ARAC tasks within 120 days of receipt of the request, our rulemaking resources are limited, and we are finding it more difficult to meet these commitments. We are looking at available options, including revising the operating procedures, to assure effective, efficient use of information received from industry through the ARAC process.

Your request has been forwarded to the agency's Rulemaking Management Council for review. The Council should render a decision within the next few months.

As always, we appreciate the support you continue to provide to our aviation rulemaking program.


Anthony F. Fazio
Director, Office of Rulemaking

EAWC

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Recommendation



U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: Certification of 30-Second and 2-Minute One-
Engine-Inoperative (OEI) Ratings for Rotorcraft
Engines

Date:

Initiated By: ANE-110

AC No: 33.XX

Change:

1. **PURPOSE** This advisory circular (AC) provides information and guidance on acceptable methods, but not the only methods of compliance for demonstrating compliance with the specific requirements applicable to 30-second and 2-minute One-Engine-Inoperative (OEI) rotorcraft engine ratings in part 33 of the Federal Aviation Regulations, Title 14 of the Code of Federal Regulations (CFR). Although this AC does refer to regulatory requirements that are mandatory, this AC is not, in itself, mandatory. This AC neither changes any regulatory requirements nor authorizes changes in or deviations from the regulatory certification requirements.

2. RELATED REGULATIONS and REFERENCES.

- a. 14 CFR Part 21, Certification Procedures for Products and Parts
- b. 14 CFR Part 27, Airworthiness Standards: Normal category rotorcraft, §27.45(f)
- c. 14 CFR Part 29, Airworthiness Standards: Transport category rotorcraft, §29.45(f).
- d. 14 CFR Part 33, Airworthiness Standards: Aircraft Engines
- e. 14 CFR Part 91, General operating and flight rules, §91.3
- f. Society of Automotive Engineering, Aerospace Recommended Practice, Certification Considerations for Highly-integrated or Complex Aircraft Systems, SAE ARP 4754

3. BACKGROUND.

- a. The Amendment 18 of FAR 33, published in Federal Registrar on June 19, 1996, incorporated definitions of the 30-second and 2-minute OEI ratings for rotorcraft engines

in FAR 1.1, and specific type certification standards for the ratings in part 33 of 14 CFR. §§33.4, 33.7, 33.29, 33.67, 33.85, 33.87, 33.88 and 33.93 were revised by this Amendment.

b. The 30-Second OEI rating provides a short burst of high power to complete the takeoff, or effect a rejected takeoff, should an engine failure occur at critical decision point so that the rotorcraft can lift clear of any obstructions in the flight path and climb out, or alternatively, to reject takeoff. Similarly, this rating also provides adequate power for rotorcraft to execute a safe landing or a balked landing if an engine fails at any point down to and including the landing decision point. The 2-minute OEI rating provides adequate power for the rotorcraft to climb out from takeoff or balked landing to a safe altitude and airspeed.

c. The ratings are optional and to be selected by the engine manufacturers among the OEI ratings available in part 33, §33.7. The significant difference between the 30-second/2-minute OEI rating and other OEI ratings of duration of 2 1/2 minutes or longer is that of limited use in service with mandatory inspection/maintenance requirement after each use of those two rating powers.

d. The subject of the type certification standards for those OEI ratings was identified as one where differences existed between the part 33 of the FAR and the Joint Aviation Requirements - Engines (JAR-E). A working group composed of representative of the Federal Aviation Administration (FAA), the Joint Aviation Authorities (JAA), Transport Canada and industry worked to produce a set of harmonized certification requirements that was incorporated into part 33 of 14 CFR. This AC is intended to provide guidance in implementing these requirements during certification.

4. GUIDANCE

§33.5 Instruction manual for installing and operating the engine.

Power performance data for rotorcraft engines having one or more OEI ratings:

(a) For rotorcraft engines having one or more OEI ratings, the applicant should provide, in the installation instructions the necessary engine data to support the installer for meeting the power availability requirements of §27.45(f) or §29.45(f). These data should include the effects of those installation losses that can be defined at the engine level. Such installation losses should include customer bleed, customer power extraction, and others as appropriate up to and including the highest power rating.

(b) The objective of this requirement is to allow the installer to ensure that the engine is capable of obtaining and sustaining the OEI ratings within the associated operating limitations. The required engine data are intended to be used for establishing a procedure for trending of individual engine performance by the operator. These data should support maintenance procedures, intervals, and standards applicable to the engine including

sensors and indicating systems, to detect those latent or dormant conditions which are not detectable through the normal rotorcraft power assurance procedures (e.g. fuel control maximum flow capability, measured turbine temperature, speed limits, etc. - -), or because the procedure will not include a topping check to the highest OEI rating power level. The dormant failures, which could lead to non availability of the rated power of the OEI ratings, should be analyzed and the results of this review should be part of the data required under 33.5(4). The adequacy of these procedures, intervals and standards, should be validated on the basis of the engine and engine systems failure modes and effects analysis (FMEA). The engine database should include a thermodynamic model, experience gained during development and certification testing, and field experience gained with this engine type or engine of similar design, when applicable.

(c.) In order to satisfy the power availability requirements of FAR 27/29.45(f) the data required under FAR 33.5 should enable the installer to establish power assurance procedures in which the extrapolation of power assurance results can be achieved from a lower power check level to the highest OEI rating power. The performance extrapolation may be accomplished by comparing the performance characteristics with the minimum acceptable engine performance in a deteriorated state. The establishment of the minimum acceptable engine performance characteristics depends on the existence of a reliable database. In a mature engine program, it is possible to use the new production engine acceptance test data, engine-to-engine variation, and also testing on engines prior to overhaul to determine the effects of deterioration. Thus, an up-to date minimum engine performance characteristic can be maintained.

For a completely new design engine, or a remote derivative of an existing design, it may be somewhat difficult to establish the initial database. The experience from engine development and certification tests could be used. This experience usually includes several thousand hours of running time to schedules which are often far more rigorous than normal commercial service. The information gathered from these tests could provide a sufficient data base for the assessment of in-service engines including the rate of deterioration. The testing of engines in production will eventually establish engine-to-engine variation, but an estimated worst variation should be assumed initially, based on the experience of engines of the same or similar design.

(d) The applicant should also provide information on methods by which to assure that engine limiter settings would not prevent the engine from reaching 30-Second or 2-Minute OEI power. These engine limiter settings may include engine speed, measured gas temperature, fuel flow, and torque.

§33.7 Engine ratings and operating limitations

(a) The 30-Second and 2-Minute OEI power ratings for rotorcraft engines are two separate ratings, however they are associated in a combined structure of 2.5 minutes duration, composed of 30 seconds at the 30-Second OEI power immediately followed by

2 minutes at the 2-Minute OEI rating power with regards to the terms of the test requirements and advisory material.

(b) The 30-Second and 2-Minute OEI ratings are optional ratings that may be specifically requested by the engine manufacturer, and are intended for use only for continuation of the one-flight operation after the failure of one engine in multiengine rotorcraft during takeoff, climb, or landing. The 30-Second OEI rating provides a short burst of high power to complete the takeoff, or to effect a rejected takeoff, should an engine failure occur at the critical decision point, so that the rotorcraft can lift clear of any obstructions in the flight path and climb out, or alternatively, to reject the takeoff. Similarly, this rating also provides adequate power for rotorcraft to execute a safe landing or a balked landing if an engine fails at any point down to and including the landing decision point. The 2-Minute OEI rating provides adequate power for the rotorcraft to climb out from takeoff to a safe altitude and airspeed or to perform a balked landing. The usage of a power level at each of the ratings is limited in duration.

(c) While the 30-Second and 2-Minute OEI ratings were originally conceived as high power ratings, using the available margins in the engine design, and followed by a mandatory engine overhaul, the experience has shown that the manufacturers provide engines which have different capabilities and use a different amount of the margins. Therefore, some flexibilities are possible in defining the mandatory maintenance actions, provided they are appropriately validated during certification.

(d) These ratings have been intended for one usage per flight in an emergency during the takeoff or landing phases. Nevertheless, the certification requirements have been defined around the worst case scenario involving the possible use of these ratings three times in one flight (i.e., the event at takeoff, balked landing, and final landing.). While not initially intended, it is recognized that the ratings could also be inadvertently used in some unexpected, non-critical conditions like an engine failure in a rotorcraft flying at a high speed cruise. In all cases, the required mandatory maintenance actions apply after any use of the rating powers.

(e) In some circumstances, the highest power used during a 2.5 minute duration OEI event might be lower than the 30-Second OEI power band but still inside the certified power of the 30-Second and 2-Minute OEI ratings power combination. In this case, it is permissible to extend the use of the 2-Minute OEI rating power to a total duration of 2.5 minutes. However, the additional 30 seconds period will be considered as a derated 30-Second OEI rating. For the required mandatory maintenance actions, see section (a) and (b) under § 33.4 of this AC and Appendix A33.4 (Airworthiness Limitations Section).

(f) The 30-Second and 2-Minute OEI power ratings must account for deterioration observed from the applicable portion of the two-hour supplementary test of Section 33.87(f). Refer to section (b) and (c) advisory material of 33.93 for additional guidance.

§33.14 Start-stop cyclic stress (low-cycle fatigue)

(a) Rotorcraft engines for which the 30-Second OEI and 2-Minute OEI ratings are desired, the applicant should provide a method to account for the low cycle fatigue effects from the usage of those two OEI ratings during the life of the engine. This may be accomplished by adding a reasonable anticipated finite numbers of cycles to the expended life of components for each of the two OEI power ratings, or by using appropriate life reduction factor(s) for engine components for each usage of the OEI rating power.

§ 33.29 Instrument Connection.

(a) The required means, provided by the engine manufacturer or by the rotorcraft manufacturer, are intended to automatically record the entry into and subsequent usage of the defined power levels, and to enable the pilot to be automatically alerted to the entry into the power levels and the corresponding impending time expiration and time expiration point. The automatic recording should be compatible with the maintenance instructions prescribed for these ratings. In particular, it should record the number of usage and time of each usage, or accumulated time, including any exceedence of 30-Second and/or 2-Minute OEI operating limitations or relevant time limitations. It should also provide a means to alert the maintenance personnel that usage and/or exceedence of the 30-Second and/or 2-Minute OEI ratings have taken place. See also paragraph (e) of §33.7 guidance of this AC regarding exceedence of the 2 minute time limitation at 2-minute OEI power.

(b) The overall development assurance level of the recording and retrieval system should be consistent with its classification of at least hazardous based on failure condition classification as defined in SAE ARP 4754. The development assurance level(s) of the components of the systems used to record usage and to retrieve the record of the 2-Minute and 30-Second OEI powers should be based on the criticality of the function(s) performed within the recording and retrieval system as determined through a system safety analysis (SSA). The overall system assurance level can be achieved based on an appropriate combination of system architecture and component assurance levels. The objective is to ensure that the information needed for the mandatory maintenance action is available after the use of OEI powers and to avoid continued operation of the engine in a potentially unsafe condition.

If the recording or retrieval system is not part of the engine, the engine type certificate holder is responsible for specifying, in the installation instructions, the required failure condition classification, system design features and interface requirements (e.g., reliability, design assurance level, software level, lightning and high energy radiated frequency, etc.), for the OEI engine data recording and retrieval system. If software is used for recording and data retrieval, the specified requirements must comply with 33.28(e)/JAR E-50(c).

(c) The recording systems should only be able to be reset by the maintenance personnel

and not by the flight crew in order to prevent further engine operation without having taken the prescribed mandatory post-flight inspection and maintenance actions.

(d) For the purpose of complying with 33.29(c), the 30-Second OEI power level is considered to be reached whenever one or more of the operating limitations applicable to the 2-Minute OEI power are exceeded. The 2-Minute OEI power level is considered to be reached whenever one or more of the operating limitations applicable to the next lower OEI rating, or other engine rating, are exceeded.

§ 33.67 Fuel system

(a) The 30-Second OEI rating is intended to provide a rotorcraft with a power reserve in the event of one engine becoming inoperative. The flight and operating conditions requiring use of this rating may create a high pilot workload to maintain safe flight. Therefore the 30-Second OEI rating must be applied and controlled by an automatic means that requires no pilot input or control other than termination command. Once activated, it automatically controls the 30-Second OEI power and prevents the engine from exceeding its limits, specified in the engine's type certificate data sheet associated with this rating. Because the 30-second OEI rating could already use almost all the available margins in the engine design, it is considered that exceeding the limits associated to this rating could result in an engine failure, which would be unacceptable in a critical flight condition with already a failed engine. This required automatic control of the 30-Second OEI power within its operating limitations is intended to avoid the need for monitoring engine parameters such as output shaft torque or power, output shaft speed, gas producer speed, and gas path temperature. Such means for automatic control within the operating limitations should be effective during normal and abnormal operations. Means, other than an automatic limiter, may be proposed to satisfy this paragraph. The engine manufacturer should not put a hard limiter on the time limit criteria, thus allowing the pilot to deal with emergency cases (e.g., §91.3(b)).

(b) The means for automatic control within the limits should not prevent the engine from reaching and maintaining its 30-Second OEI power.

§ 33.83 Vibration test

(a) §33.83 (b) prescribe the required ranges of power, and both the physical and corrected rotational speeds for vibration survey. For 2-minutes OEI rating, the test speed should be from the minimum rotational speed up to 103 percent of the maximum physical and corrected rotational speed permitted for the rating. For 30-second OEI rating, the test speed should be from the minimum rotational speed up to 100 percent of the maximum physical and corrected rotational speed permitted for the rating. All other requirements in §33.83 (b) apply to both OEI ratings.

§ 33.85 Calibration tests.

(a) Since the rotorcraft engine operation at 30-Second and 2- minute OEI ratings could significantly affect engine hardware conditions, these engine rating powers are therefore not required to comply with §33.85(a), (b), and (c). However the calibration test requirements of the short time OEI ratings (less than 2 1/2 minutes) could be satisfactorily substantiated during the endurance test without compromising the purpose of the calibration test.

(b) Any available information from tests of Section 33.87(f), 33.88, and 33.90 should also be used for establishing the engine characteristics throughout the engine's operating envelope. In particular, the power for the 30-Second and 2-Minute OEI ratings must reflect the rated power deterioration that is observed from the pre-test calibration prior to the additional endurance test of 33.87(f) through and including the third application of 30-Second rated power -- the power deterioration through the third application is expected to be the best indicator of the worst case power deterioration that could occur during actual usage of the rating, and thus should be reflected in the data given to the aircraft manufacturer to define performance characteristics of the aircraft system. In the event of power deterioration exceeding 10% at the 30-Second rating over the course of the 2-hour test, the mode of deterioration must be evaluated to ensure that the availability of 30-Second rated power in service will not be compromised by deterioration variability.

§ 33.87 Endurance test.

(a) A two-hour supplementary test of Section 33.87 (f) is added to the basic 150-hour endurance test for the rotorcraft engines for which the 30-Second OEI and 2-Minute OEI ratings are desired. The test must run on the same engine parts after completing 150-hour endurance test except for those parts defined as consumable. It is recommended that the applicant disassembles the tested engine and inspects the engine components at the conclusion of the 150-hour test but prior to the supplementary test, using the criteria specified in Section 33.93 (a). Then engine shall be subject to a second teardown inspection after completing the supplementary test, using the criteria specified in Section 33.93(b). If the applicant elects not to disassemble and inspect the engine prior to starting the supplemental test, then the teardown inspection requirements of Section 33.93(a) apply on completion of the test. The level of component cleaning to facilitate inspection prior to rebuild for the additional 2-hour endurance test must be acceptable by the cognizant ACO. It must also be shown that any cleaning during the teardown inspection, or replacement of consumable parts, will not enhance the engine's ability to meet the 33.93(b) requirements of the additional endurance test.

(b) The four test sequences are to be run continuously for the required two-hour test duration without stoppage. In the event of a stop occurring, the interrupted sequence needs to be repeated in full or can be re-started from the interrupt point if there are technical justifications acceptable to the cognizant ACO. If it is determined that the sequence needs not to be repeated in its entirety, the test should be re-started from a point where the engine thermal condition would be the same as at the time of interruption. If an

excessive number of interruptions occur, the applicant would be required to repeat the entire test.

(c) The power level of test condition (f)(4) is intended to demonstrate the highest en-route power, OEI, or non-OEI power. During scheduled accelerations and deceleration, the power or thrust control lever should be moved from one extreme position to the other in a time not more than one second. All applicable paragraphs of 33.87(a) including (a)(1) through (a)(6) must be considered in running the two-hour test.

However, for reducing test complexity, and for improved flexibility needed to attain the key parameters (speed, temperature and torque) during the test of paragraph 33.87(f), maximum air bleed for engine and aircraft services under (a)(5) need not be used if the applicant can show by test or analysis based on test that the engine's ability to meet the teardown inspection requirements of subparagraph 33.93(b)(2) is not enhanced. The analysis should include (1) the effect of the bleed air extraction to the engine secondary air system which provides cooling air to various engine components, and (2) the thermodynamic cycle effects of bleed (e.g., core speed to output shaft speed changes).

If the power turbine accessory drives are not loaded, the equivalent power must be added (as required in 33.87(a)(6)) to the required power at the output drive so that the power turbine rotor assembly is operated at or above the same levels as it would be if the power turbine accessory drives were loaded.

(d) The engine operating limitations of 30-Second and 2- minute OEI ratings defined in the type certification data sheets (TCDS) will be based on the minimum values obtained during the applications of the 2 hour test of Section 33.87(f). Due allowance should be made for stabilization time and the limits of accuracy for the instrumentation or automatic controlling system declared in accordance with Section 33.29(c) and 33.67(d).

§ 33.88 Engine overtemperature test.

(a) For the purpose of the test, the maximum power-on rpm is normally the steady state rotor speed associated with 30-Second OEI rating. However, this speed will be substituted by the transient rotor speed if the engine characteristic transient speed stabilization exceeds 3 seconds during the transition to 30-Second OEI rating power.

(b) The gas temperature increase for conducting the test (e.g. 75 degrees F in (a) or 35 degrees F in (b)) is based on turbine inlet gas temperature at the location immediately in front of the first stage high pressure turbine rotor.

(c) After the overtemperature test, the turbine assembly may exhibit distress beyond serviceable limits provided that no burst, no blade failure and no other significant failure of any engine component would occur, or become evident during the test, during shutdown, or during the subsequent teardown inspection. In the event that any potential failure becomes evident, this shall be analyzed and it shall be established by analysis or test that

the cause is not such that in service the OEI rating structure would not be satisfactorily achieved.

§ 33.93 Teardown inspection.

(a) After the additional endurance tests of section 33.87(f), the applicant should show that no failure of any significant engine component is evident during the test, during shutdown, or the subsequent teardown inspection. In the event that any failure is evident, this should be analyzed and it should be established by test or analysis or both that the cause is corrected, or certain limitations are imposed to the engine as appropriate. For the purpose of this Section, the engine parts that are deemed significant are those that can affect structural integrity, including, but not limited to mounts, cases, bearing supports, shafts, and rotors.

(b) For components which are distressed beyond serviceable limits by this test, it must be shown that the inspections and mandatory maintenance actions for these components, specified in the Instruction for these components, are adequate for maintaining continued airworthiness. The instructions should include means for proper identification of these component conditions, and appropriately defined maintenance actions. The component deterioration during the test in terms of performance effects, should be determined. The component distress seen as a result of the additional test should not indicate potentially hazardous condition. In addition to visible physical damage, non-visible damage should be assessed -- such damage may include but not necessarily be limited to the effects of creep, stress rupture, metallurgical effects, life usage, etc. This overall evaluation should then be considered when defining and justifying the inspections and mandatory maintenance actions for Continued Airworthiness Instructions.

§ 33.4 Instructions for Continued Airworthiness.

Inspection and maintenance requirements for rotorcraft engines having 30-Second and 2-Minute OEI power ratings.

(a) The maintenance actions are determined through certification testing including, where applicable, endurance tests, overspeed tests, overtemperature tests, maintenance tests and supplemented by development testing and service experience of engines of the same or similar design. Servicing information should cover maintenance details regarding servicing points, inspections, adjustments, tests, and replacement of components if required. The mandatory inspection and maintenance actions for a certified engine considered under the Appendix A33.4(b)(1) may also evolve after entering service, based on its service experience.

(b) For rotorcraft engines with 30-Second and 2-Minute OEI ratings, the Airworthiness Limitations section of the Instructions for Continued Airworthiness are required to prescribe the mandatory post-flight inspection and maintenance actions which are applicable following the use of either of these two ratings, or both, regardless of the

frequency, prior to next flight. If the 2-Minute OEI rating time period is extended to 2 1/2 minutes, the additional 30-Second period is considered as a derated 30-Second OEI rating, and the maintenance actions prescribed for the 30-Second OEI rating should be used. Alternately, the applicant may seek approval for prescribing a different set of inspection and maintenance actions for time exceedence of engine operation at the 2-Minute OEI rating, if this is appropriately justified and validated. For instance, if the engine is essentially the same as one which has a 2 1/2-minute OEI rating equivalent to the new 2-Minute rating, then the maintenance considerations of the 2 1/2-Minute OEI rating might also be applicable after use of the 2-Minute OEI rating for up to 2 1/2 minutes. If only the accumulated usage time is to be recorded under 33.29(c)(2), the inspection and maintenance action prescribed as required by 33.4 must always be based on the total recorded time duration regardless the number of application at the ratings used in one flight.

(c) The 30-Second and 2-Minute OEI ratings were originally intended to safely use available engine design margins for brief periods of exposure with resulting allowable component deterioration beyond serviceable limits and not available for further use. The extent to which use of the ratings cause component damage or life reduction is primarily a function of engine design margins, application exposure level and duration, hardware condition prior to use, and operating environment. Because engine operation conditions and time recording are requirements for this rating, the maintenance actions can be related directly to an actual documented usage level, time, and, if applicable, known condition prior to rating application (hours/cycles/prior rating exposure, etc.). Depending on the actual operating parameters such as temperature and time exposure which are recorded during usage of these ratings in accordance with §33.29, it is possible to predefine a maintenance action and decrement of the remaining time before overhaul or component replacement, based on the type, level and duration of exposure. If the mandatory maintenance instructions result in no maintenance action, then the minimum requirement would be the interpretation of recorded event data and documentation of the data in the maintenance log(s). The Instructions for continued airworthiness should also include the definition of data to be provided by the operator to support the applicant in completing the engine in service evaluation program.

Validation of mandatory post-flight inspection and maintenance actions

(d) At any time during its service life the engine must be maintained in a condition so that the 30-Second and 2 -minute OEI ratings can be attained and sustained. This requirement has a bearing on both power assurance procedures and instructions for continued airworthiness. The mandatory maintenance following the use of 30-Second or 2-Minute OEI rating should be capable of identifying and correcting any component distress which could significantly reduce subsequent engine reliability or prevent the engine from achieving or sustaining further application of the OEI ratings. The applicant should provide evidence by endurance test results, analysis based on test data of the endurance tests, and/or other certification tests and service experience of similar type and design of engines to show that the power at 30-Second and 2-Minute OEI ratings is achievable and

can be sustained for the respective duration at any time between overhauls or major maintenance of the engine.

(e) Essential to the establishment of mandatory maintenance instructions is a thorough knowledge of the potential damage incurred with use of the 30-Second and 2-Minute OEI ratings, and more importantly the remaining margin to component failure or reduced engine performance due to use of these OEI ratings. The certification procedures for 30-Second and 2-Minute OEI ratings emphasize demonstrating design adequacy by endurance testing and by specific margin tests for turbine temperature, rotor speeds, etc. An understanding of operating margins to various failure modes when operating at the 30-Second and 2-Minute OEI ratings is needed for establishing adequate Instructions for Continued Airworthiness. These failure modes and margins should be determined and validated by appropriate methods or experience, which may include but not be limited to:

- Design Analytical Predictions
- Service Experience of Identical or Similar Design
- Actual Test or Service Failure Experience
- Results of OEI Certification Tests
- Dedicated Engine and Component Tests
- FMEA Predictions

(f) Understanding of failure modes may come by service experience where hardware distress or failure was caused by known exceedence operation. Alternatively either component or engine level exceedence testing could be useful in evaluating failure mode margins, indications, power decay characteristics and severity. Approaches to establishing failure margins is very design and experience dependent and could vary greatly between engine types. One test method which illustrates the objective of failure margin assessment from the 30-Second OEI rating condition is to progressively increase engine fuel flow to the point where either an abrupt failure occurs or where power begins to decay due to component degradation. Results of such a test could establish margins to and consequence of component failure. This could be useful in establishing the appropriate maintenance instructions. Potential failure modes are design dependent however most would be related to excessive turbine temperature or engine overtorque. Some potential failure modes could include but not be limited to:

- Blade Stress Rupture
- Vane Distortion / area change
- Case distortion
- Disc, Spacer, or Seal Growth / Rub
- Creep
- Incipient Melting
- Rub Induced HCF
- Blade Release

(g) The 30-Second and 2-Minute OEI ratings are intended to safely use available engine design margins for brief periods of exposure with resulting allowable component deterioration beyond serviceable limits. The extent to which use of the ratings cause component damage or life and reliability reduction is primarily a function of engine design margins, application exposure level and duration, hardware condition prior to use and operating environment. Because engine operation conditions and time recording are requirements for this rating the maintenance actions can be related directly to an actual documented usage level, time, and if applicable, known condition prior to rating application (hours / cycles / prior rating exposure etc.). The mandatory maintenance actions may range from one extreme to the other of:

- Recording Parameters and Times in Maintenance Records
- Visual Inspection (s) and Results
- Power Assurance / Trend Check
- Reduction in Time to Overhaul or Component Change
- Addition of Special Inspection and Intervals
- Module Change / Overhaul
- Engine Removal / Overhaul

(h) The mandatory maintenance actions should provide inspection procedures which can reliably ascertain component distress and their continued airworthiness, define life reduction or require certain component replacement, repair or overhaul. Derivative engines with extensive service history can draw upon that experience coupled with OEI testing and failure mode / margin knowledge to establish maintenance requirements with a high degree of confidence. A new type design may have to rely on design / FMEA predictions, development / certification / flight test, and dedicated failure mode test experience to form the basis for establishing OEI usage maintenance requirements. These initial requirements could later be altered based upon documented service experience and or additional development test.

(i) The engine manufacturer should undertake the necessary actions including instructions in engine manuals, to make sure that the operators are aware of the need and understand the procedures to properly collect and return the information necessary for the engine manufacturer to monitor the adequacy of the prescribed mandatory maintenance actions.

Program to Validate Continued Airworthiness Instructions and Power Availability

(j) In order to comply with Section 33.4, Appendix A, an in-service engine evaluation program to assure the continued adequacy of the airworthiness instructions and of power availability must be provided and be approved by the cognizant Aircraft Certification Office (ACO) prior to certification.

The intent of this program is to obtain relevant data concerning engine hardware condition and power availability at various stages in the life of the engine hardware critical to the achievement of the ratings and to compare that data to corresponding data observed

during the certification process that defined the airworthiness instructions. Differences may exist in hardware condition and power availability characteristics from in-service engines that have not experienced any usage of the 30-Second or 2-Minute OEI ratings versus similar parameters that existed prior to the two-hour supplementary test of Section 33.87(f).

Similarly, differences may exist in hardware condition and power assurance characteristics from in-service engines after usage of the 30-Second or 2-Minute OEI ratings versus similar parameters observed following the two-hour supplementary test of Section 33.87(f).

Proper definition of the continued airworthiness instructions is expected to have anticipated and accounted for such in-service conditions -- this program should however be structured to validate that such in-service differences are properly accounted for. If the data obtained during the execution of the program indicates that the in-service differences are not properly accounted for, then the data from the program or from additional engine testing should be used to modify the instructions as appropriate.

(k) When the continued airworthiness instructions for usage of the 30-Second or 2-Minute OEI ratings are defined during the certification process, data are available from multiple sources that should be considered when defining the in-service engine evaluation program. These sources of data may include, but are not limited to the following areas:

- Whether the engine is a new type design, a derivative, or a derivative that already incorporates 30-Second and 2-Minute OEI ratings.
- Degree of applicable service experience on identical or similar designs.
- Certification and development test results -- this data will indicate if the ratings are aggressive or conservative and whether the use of the ratings causes additional distress or no distress to the engine hardware.
- Knowledge of failure modes and margins to failure.

The in-service engine evaluation program must include some type of service engine testing and/or evaluations of service usage of the 30-Second/2-Minute Ratings -- although equivalent service engine test experience on engines of similar design is acceptable as an alternative. This part of the program would consist of, but not be limited to, one or more of the following elements.

- Scheduled tests of in-service engines (3 applications of 30-Second OEI rated power), while either installed in the rotorcraft or in an engine test cell. For selected representative aged engines the program would include number and frequency of samples, as well as inspection/test requirements. Such requirements may include recording of data with respect to available power, power assurance validation, and hardware condition before/after 30-Second and 2-Minute OEI rating usage.

- **Unscheduled tests of engines of opportunity (3 applications of 30-Second OEI rated power).** The program may include actions to be taken when engines become available that meet certain predetermined criteria. Definition of selection criteria for representative aged engines should be included in the program. Inspection/test requirements on such engines **should** include the recording of data with respect to available power and the identification of the hardware condition before/after 30-Second and 2-Minute OEI rating usage.
- **Service usage of 30-Second/2-Minute OEI rated power.** This may include recorded power available data, post usage power available data, and results of the mandatory maintenance and inspection actions.
- **The equivalent service test on engines of similar design is acceptable, although representativity must be assessed.**

The aircraft certification testing of the 30-second and/or 2-minute OEI ratings could also provide additional recorded data with respect to available power, post-usage power available data and results of hardware maintenance and inspection of the engine(s) to support the program. In addition to the in-service engine tests, the in-service engine evaluation program may also include test evidence from development or certification test to reduce, but not eliminate, the number of service engines required for the in-service engine evaluation program.

During the execution of the in-service engine evaluation program, the continuing airworthiness instructions should be modified as needed based on the results obtained. Similarly if circumstances warrant, the program itself may need to be modified as additional in-service data becomes available.

- (l) The information or actions needed from the operator to support this in-service engine evaluation program of paragraph (b)(2) may be prescribed in the Airworthiness Limitations section.

Jay J. Pardee
 Manager, Engine and Propeller Directorate
 Aircraft Certification Service

FAA Action

Mr. Craig R. Bolt
Manager, Product Development and Validation
Pratt & Whitney
Mail Stop 162-12
East Hartford, CT 06108

Dear Mr. Bolt:

In an effort to clean up pending Aviation Rulemaking Advisory Committee (ARAC) recommendations on Transport Airplane and Engine Issues, the recommendations from the following working groups have been forwarded to the proper Federal Aviation Administration offices for review and decision. We consider your submittal of these recommendations as completion of the ARAC tasks. Therefore, we have closed the tasks and placed the recommendations on the ARAC website at <http://www.faa.gov/avr/arm/arac/index.cfm>

| Date | Task | Working Group |
|----------------|--|---|
| December 1999 | Interaction of Systems and Structure Part 33 Static Parts | Loads and Dynamics Harmonization Working Group |
| March 2000 | Part 35/JARP: Airworthiness Standards Propellers | Engine Harmonization Working Group |
| April 2000 | Flight Characteristics in Icing conditions | Flight Test Harmonization Working Group |
| May 2000 | Thrust Reversing Systems | Powerplant Installation Harmonization Working Group |
| September 2000 | Lightning Protection Requirements | Electromagnetic Effects Harmonization Working Group |
| July 2001 | Main Deck Class B Cargo Compartments | Cargo Standards Harmonization Working Group |
| April 2002 | Design Standard for Flight Guidance | Flight/Guidance Systems Harmonization Working Group |
| | | |

I wish to thank the ARAC and the working groups for the resources they spent in developing these recommendations. We will continue to keep you apprised of our efforts on the ARAC recommendations at the regular ARAC meetings.

Sincerely,

Anthony F. Fazio
Executive Director, Aviation Rulemaking
Advisory Committee